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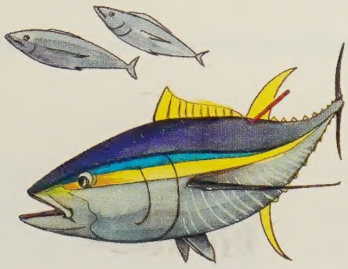


Pelagic Fisheries Research Program

Volume 5, Number 4

October–December 2000

Swordfish Fisheries and Management Today

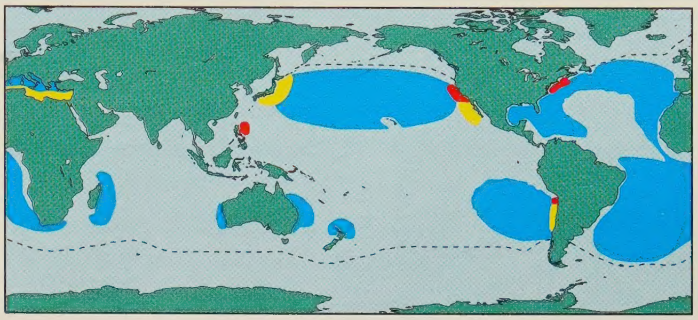
Peter Ward

Globally, swordfish catches are increasing. Swordfish are a high-value catch that represent an increasingly important source of revenue to many coastal nations in the Pacific and Indian oceans, e.g., Australia and La Réunion. Optimistic that they can continue to increase swordfish catches, fishers are purchasing fishing permits and investing in new, larger boats. However, several swordfish fisheries around the world have shown initial, rapid expansion, then declined, prompting concern over the species' ability to support intensive harvesting.

In response to the rapid expansion of fisheries, Australia's Bureau of Rural Sciences (BRS) reviewed the status of the world's swordfish fisheries. The BRS report[1] includes detailed information on management arrangements, the fishing gear and techniques used to target swordfish, and the seasonal and geographic distribution of catches.

Swordfish Differ from Other Species

Like other billfish and tuna, swordfish are highly fecund, migratory fish that grow quickly in their early years and become apex predators. Tuna and billfish are truly oceanic and difficult to study. Swordfish have a wider geographic distribution (50°N–50°S) than other billfish and tuna. They routinely move between surface waters and great depths where they tolerate extreme cold (below 8°C). They do not form schools. Results of recent research suggest that the Pacific Ocean is comprised of several semi-independent swordfish stocks (a northern stock, a southwestern stock and two or three eastern stocks). Swordfish move with prevailing currents and use their highly developed sight to stalk prey. Female swordfish grow faster and live longer than males. They reach their maximum size (usually ~350 kg) at about 15 years of age. Male and female swordfish have different distributions depending on size.



Map showing areas of longline (targeted) [blue], harpoon (red), and driftnet (yellow) fishing. The dotted line denotes the limit of distribution.

Within swordfish populations, a proportion of the fish associates with underwater features such as banks and seamounts. Such features were often the focus of fisheries when they first began to develop. Modern longliners are potentially capable of removing these 'resident' components of swordfish populations at a greater rate than they can be replaced by growth and immigration. Swordfish may thus be inclined to local depletion around underwater features.

Evolution of Swordfish Fishing

Swordfish fishing started thousands of years ago as a near-shore subsistence activity in subtropical areas, where fishers harpooned large, female swordfish basking at the sea surface. Anecdotal reports suggest that large swordfish were more abundant when commercial fishing commenced in the

(continued on page 2)

[1] For US$25 (including postage) you can purchase a copy of the BRS review of swordfish fisheries from: The AFFA Shopfront, Agriculture, Fisheries and Forestry–Australia, GPO Box 858, Canberra ACT 2601 AUSTRALIA. Or contact them by telephone at (612) 6272 5550, Fax (612) 6272 5771, or e-mail at shopfront@affa.gov.au.

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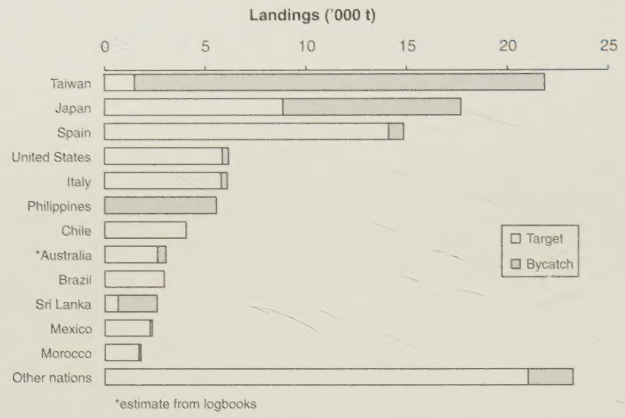


Graph showing swordfish landings by country.

1800s than they are in many areas now. Swordfish fisheries changed dramatically when fishers upgraded to monofilament driftnet and longline fishing gear in the 1980s. In addition, large swordfish are a prized catch of recreational anglers, although in most areas gamefishing tends to focus on other billfish, such as blue marlin.

Distant-water longliners, which typically spend several months at sea and freeze their catches, started to target swordfish early in the 1950s; in the 1960s many distant-water longliners started targeting sashimi tuna, such as yellowfin, instead.

In the mid-1980s fishers realised the potential for smaller (10–25 m) longliners to make shorter fishing trips, store tuna and swordfish on ice, and airfreight the fish to distant markets. Unit prices paid for fresh-chilled swordfish in the United States and Europe are generally lower than those paid for sashimi tuna in Japan. However, boats can undertake longer fishing trips for fresh-chilled swordfish because it has good storage qualities and its price is less sensitive to product quality. Fresh-chill longline fleets quickly developed in many of the world's ports. Driftnet boats also target swordfish, and distant-water tuna longliners take a substantial bycatch of swordfish. During the 1980s and 1990s, longliners and driftnet boats increased swordfish catches to high levels.

Factors Affecting Fisheries and Prices

In addition to increasing catch levels, the introduction of monofilament longline gear resulted in the expansion of fishing into offshore waters and lower latitudes, where small, juvenile swordfish were typically more abundant. The expansion of fishing grounds also broadened the range of swordfish size in catches. However, expansion often concealed declines in swordfish abundance, as well as degradation of fish size on the original fishing grounds.

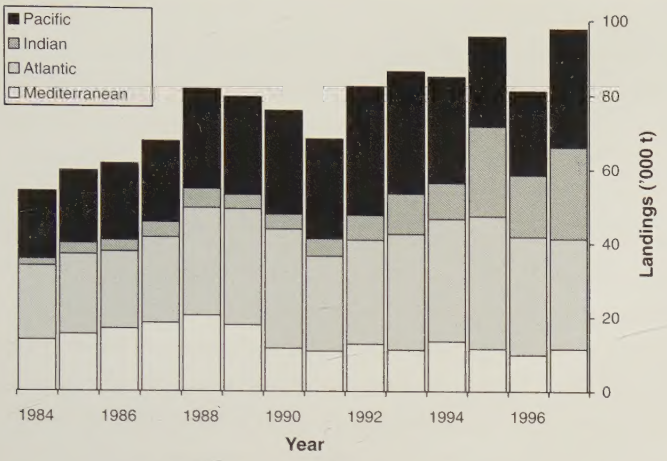
Longline fisheries for swordfish often develop as follows: the risk-takers in the fleet progressively move further offshore, initially enjoying high catch rates. Other boats follow, and the fleet ranges further offshore for longer periods, tolerating more extreme weather conditions. Hawai'i-based longliners, for example, regularly make trips of more than 30 days. They venture 1000–2000 nm from port and average about 250 sea days per year. Such expansion shows the potential for increases in effort in other fresh-chilled fisheries, like Australia's. To allow informed decisions on economic efficiency, fishers and fishery managers require an

Logistics of Swordfish Research

Assessment of swordfish stocks requires knowledge of stock structure and mixing, age and growth, and natural mortality. Tag–recapture experiments are often used to obtain such information for other marine fish, but swordfish are notoriously difficult to tag. Archival and pop-up tags might provide information on swordfish movement and behaviour.

Knowledge of inter-annual variability in swordfish abundance, changes in ocean productivity, and the effects of broad-scale oceanographic events like El Niño might aid the interpretation of catch rates and management of several swordfish fisheries, such as those off Chile and Australia.

A recent analysis suggests that size may be a more sensitive indicator of swordfish stock status than catch rates. For most swordfish fisheries, stock assessment relies on programs that sample catches when they are landed at ports. However, female swordfish grow faster than males and the size and sex composition of swordfish catches vary considerably between areas and seasonally. Longliners that supply United States markets often discard small and damaged swordfish, creating further gaps in the data collected through port sampling. Consequently, swordfish stock assessment requires a detailed breakdown of catches by location, size and sex that must be gathered by at-sea programs.



Graph showing swordfish landings per year by region.

understanding of the limits that distance and boat size place on the commercial viability of swordfish fisheries.

Swordfish is a global commodity, and markets in Europe and the United States tend to dictate swordfish prices. Catch levels declined in the 1970s in response to mercury restrictions in the U.S. and Canada, then increased when the restrictions were eased. In 1998, swordfish prices fell in response to a restaurant boycott and oversupply in the U.S. market. Further health restrictions or fluctuations in global demand will directly influence the commercial viability of many swordfish fisheries. A significant decline in the value of the U.S. dollar, for instance, might suddenly make several developing swordfish fisheries unprofitable.

Fishery Status by Global Region

Three fisheries, the Mediterranean, South Atlantic and North Atlantic, have been fished at levels that are above the estimated maximum sustainable yield (MSY). In the North Atlantic, swordfish abundance has shown a continuous decline since about 1980, with the stock eventually falling below the optimum level. Catch rates declined from 1990 to 1996, and there were fewer older swordfish in the population. However, the most recent assessment suggested that the decline in abundance has slowed and that there were strong recruitments of young swordfish in 1997 and 1998.

The status of swordfish in the South Atlantic is less certain; catches there are believed to have been above the MSY in most years since 1989. In the Mediterranean, the number of new recruits produced in 1994 was estimated to be 10 to 20% of that which an unfished stock would have produced. Fluctuations in recruitment, and the fishery's reliance on small swordfish, reflect significant reductions in the size of the parent stock. Nevertheless, swordfish are remarkably fast-growing in their early years, and in the Mediterranean seem to support relatively heavy fishing pressure.

Swordfish distribution is closely linked to ocean temperature and the abundance of prey species. Deep-sea bathymetry and oceanographic conditions suggest that there may be unexploited or lightly exploited swordfish stocks in several locations of the southern hemisphere; these include the southeastern Indian Ocean, southern Tasman Sea, across the subtropical convergence zone of the South Pacific, and associated with seamounts and banks south of French Polynesia, Fiji and Tonga. Feasibility fishing is required to evaluate the resources of those unfished areas. The development of commercially feasible fisheries in unfished areas will also depend on the proximity of fishing grounds to ports and airfreighting links and markets.

Fishery Management and Fleet Capacity

In each of the areas shown in Table 1, fishing effort continued to expand for several years after the peak in catches, highlighting the inability of fishery managers to control growing over-capacity in the fleets. This is partly due to the problems involved in predicting the sustainable catch level that the resource may ultimately support. Furthermore, expansion and over-capacity are extremely difficult to control in developing fisheries. In attempting to control over-capacity, fishery managers sometimes apply "input controls" such as limits on fleet size, vessel size and the number of fishing days. Most controls have their pitfalls, however, because fishermen are able to progressively improve the efficiency of their fishing operations.

Table 1. Growth in catch volume

Area	Initial annual catch	Peak annual catch	Period of increase	Current annual catch
Mediterranean	5,000 t	20,000 t	11 years	15,000 t
N. Atlantic	12,000 t	21,000 t	9 years	13,000 t
S. Atlantic	5,000 t	21,000 t	15 years	13,000 t
Chile	500 t	7,000 t	6 years	3,000 t
N. Pacific (Japan)	2,000 t	13,000 t	3 years	10,000 t
N. Pacific (Hawai'i)	300 t	6,000 t	3 years	3,000 t
East Australia	100 t	2,000 t	4 years	3,000 t

There is no clear evidence of swordfish stocks or their fisheries collapsing from overfishing. Their broad distribution combined with prolonged spawning periods might

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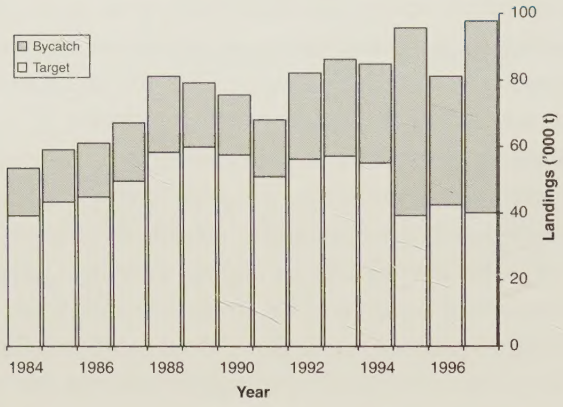

Graph showing swordfish landings per year by region.

contribute to the apparent resilience of swordfish stocks to intensive harvesting. Nonetheless, inadequate research and management are hindering the considerable economic benefits that would be derived from optimum use of swordfish resources.

Longliners are able to switch between target species (e.g., from swordfish to sashimi tuna) or relocate to distant ports in response to declining prices, poor catch rates or imposition of management regulations. Many of Spain's swordfish longliners, for example, started to target tuna or shark or relocated to the South Atlantic when swordfish catch rates declined in the North Atlantic. Fishery managers need to establish measures that encompass the ability of longliners to switch between target species and relocate to distant areas.

Six Imperatives for Developing Fisheries

1. Control fishing effort. Without controls, fishing effort will expand until it overshoots the optimum level, and catch rates and average size will not be maintained at initial levels.
2. Control geographic expansion. Otherwise, the fishery will expand to a size that threatens the commercial viability of the fleet.
3. Establish appropriate data collection programs. Swordfish are different from tuna; stock assessment requires at-sea programs to collect data on the sex-composition of swordfish catches.
4. Take a multi-species approach. Management and research must adapt so that it can address the ability of longliners to switch between target species in response to fluctuations in abundance and price.
5. Monitor and mitigate incidental catch. Fishing affects other components of pelagic ecosystems on which swordfish depend. Environmental concerns about incidental catches also may damage markets and attract harsh regulations.
6. Adopt a regional approach. Modern longliners are able to relocate to distant areas. Nations must work together through appropriate regional bodies to effectively manage and assess highly migratory species like swordfish.

Importance of Bycatch

More than half of the world's swordfish is taken as incidental catch by longliners targeting tuna. Most of that swordfish catch is frozen and sold for low prices. Bycatch presents problems to fishery management and assessment.[2] With stock assessment, it is difficult to collect data on catch, effort and size-composition of bycatch species, and it is difficult to control catches of bycatch when the fishery is targeting other species. Japan's longliners, for example, do not target swordfish in the North Atlantic. They are, however, the second largest harvester of swordfish there, landing more than 10% of the total catch.

In addition, longliners that target swordfish often take large, incidental catches of shark, particularly blue shark. Finning—the practice of removing the shark's fins and discarding the carcass—is common in many swordfish fisheries. The waste associated with finning and the broader effects of longlining on shark populations are a growing concern to fishery managers and the wider public. Fishery managers require reliable estimates of the catch levels of shark and the status of shark populations. Simple techniques, such as the use of monofilament leaders, might also be available to mitigate the incidental catch of shark.

There is scant information about the catch levels of other incidental species because observers are rarely placed on

[2] Director's note: in the U.S., a distinction is made between "bycatch" and "incidental catch." Bycatch is not sold and is usually discarded. Incidental catch is sold. In Hawai'i, considerable effort is made to find markets for non-target species, thereby converting as much bycatch as possible into incidental catch. As a result, almost all caught fish is sold, leaving birds and turtles as the major problematic bycatch species.

longliners targeting swordfish. Compared with longlining for tuna, swordfish longlining is more likely to interact with marine wildlife such as seabirds and turtles, because it usually involves shallow sets beginning in the late afternoon, at high latitudes where those species are often active. Many fishing nations have agreed to the Food and Agriculture Organization (FAO) International Plan of Action to reduce the incidental take of seabirds by longline. At a national level, fishery managers are also responding to concern over the incidental catch of seabirds and other species in swordfish fisheries. The potential for incidental catches of seal and turtle, for instance, resulted recently in significant area closures around the Hawaiian Islands.

Fishing for swordfish in the pelagic environment is simultaneously taking predators, competitors and prey. There is little understanding of fishing's effects on the wider ecosystem. Those effects will, in turn, affect swordfish population dynamics. In addition to robust assessments of swordfish status, fisheries need multi-species assessments and ecosystem approaches to their management.

Fishery Management Challenges and Strategies

Nations and regional organisations have not been particularly successful in managing swordfish fisheries. They have been unable to establish the necessary data-collection and research programs early in the fishery's development. They have allowed fleets to overcapitalise and have not always implemented restraints recommended by scientific advisers. Where restraints have been imposed, they have proved inappropriate (e.g., size restrictions) or difficult to enforce (e.g., quotas). In addition, apart from those cooperating in the International Commission for the Conservation of Atlantic Tunas (ICCAT), most nations have taken unilateral approaches, attempting independently to research and manage swordfish within their waters.

Several nations have managed their swordfish fisheries by limiting the entry of new participants. Yet inadequate support measures (e.g., boat size limits) for limited entry regulations have often allowed latent effort to build up in the fishery. Limited entry has not restrained fishing effort because fishers have been able to upgrade to larger fishing boats, set more fishing gear or spend more days at sea. Longliners were able to leave the North Atlantic swordfish

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Upcoming Events

October 23-27

9th International Coral Reef Symposium
Bali International Convention Center
Bali, Indonesia

November 6-8

Climate and Coastal Workshop
East-West Center
Honolulu, HI

November 6-9

International Fishers Forum on Solving the Incidental Capture of Seabirds in Longline Fisheries
The Heritage Hotel
Auckland, NZ

December 5-7

Pelagic Fisheries Research Program Principal Investigators Meeting
East-West Center
Honolulu, HI

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Swordfish Fisheries (continued from page 5)

fisheries before they were restrained by management regulations. Many nations have been unable or unwilling to prevent the relocation of their fleets to new areas. An important lesson from our review is the need to put in place mechanisms to control fishing effort before expansion commences and to activate those measures in a precautionary manner.

In the Mediterranean there is virtually no coordination of regulations; neither is there an overall limit on fishing effort or catch levels. Several nations have inadequate enforcement arrangements and many fleets do not comply with those regulations.

In the Atlantic, ICCAT has no regulatory authority, and member nations are not legally bound to accept its recommendations. Several members have ignored the national quotas allocated by ICCAT, and catches have regularly exceeded the total allowable catch, thereby contributing to the continuing decline of the South Atlantic swordfish stock and, in the past, the North Atlantic stock. Nations that have developing swordfish fisheries need to cooperate in regional approaches to fishery management and assessment.

The author is a Biologist with the Pelagic Fisheries Program, Fisheries & Forestry Sciences Division, Bureau of Rural Sciences, Australia. The conclusions presented in this article do not necessarily reflect the views or policies of Australian Fisheries Management Authority (AFMA) or the Bureau of Rural Sciences (BRS).

PFRP

December Workshop for PFRP Principal Investigators

The Pelagic Fisheries Research Program (PFRP) convenes occasional meetings of the scientists conducting PFRP-sponsored research. The primary purpose of these meetings is to facilitate collaboration among scientists from different disciplines.

The next meeting of principal investigators is scheduled for December 5–7, 2000, and the theme for the meeting will be "Exploitation, predation, and scales of spatial variability in pelagic fisheries." Large pelagic fish are highly dispersed in the ocean, with typical population densities of only about one fish per square kilometer integrated over the upper mixed layer.

Understanding of spatial patterns and scales of variability is one of the central issues in ecology in general, and is critical for the success of fisheries, particularly those targeting large pelagic fish. These fisheries depend on exploitation of natural and man-made points of aggregation such as oceanographic fronts, seamounts, logs, and FADs. More importantly, perhaps, our ability to estimate population size depends on the relationship between local abundance and the population as a whole.

Many PFRP projects in oceanography, biology, statistics and economics have touched either directly or indirectly on the subject of spatial variability. This emphasis will continue in several newly funded projects. One critical new project in particular will examine the relationship between feeding habits and aggregation, linking scales of spatial variability across trophic levels.

Three days have been reserved for the December workshop. About half will be devoted to presentations of PFRP projects, and about half will be devoted to discussion and presentations from invited speakers relating to spatial variability and feeding of large pelagic fish. Attendance will be limited to about 50 people.

For details, please contact Dodie Lau (dlau@soest.hawaii.edu) or John Sibert (jsibert@soest.hawaii.edu) of the PFRP, or consult the PFRP Web Site at http://www.soest.hawaii.edu/PFRP/.

PFRP

NMFS Workshops for Longliners Well Attended

Chris Anderson

The principal objective of the workshops was to teach Hawai'i's commercial longline crews how to avoid or properly handle protected species encountered at sea. Organizer Kathy Cousins, with the National Marine Fisheries Service (NMFS), says this goal was achieved, and there were some unexpected positive results of the educational workshops as well.

Among these: more comfortable communication, not only between the NMFS and Hawai'i longliner owner/operators, but also among the owner/operators themselves, who typically have few reasons to get together in a cooperative learning environment.

"I'd say the workshops have been a huge success, primarily because when the fishermen came in, you could see they were very upset and frustrated about all the litigation occurring to restrict their operations," Cousins said. "But by the time they left, they were in a better mood and seemed to have a bit of hope."

Hot Topics

The topics of greatest interest to the fishermen were proper handling techniques for protected species, and ways to avoid catching seabirds. The latter include setting at night, properly disposing of offal, using blue-dyed bait, towing seabird deterrents (the marine equivalent of scarecrows), and using line-setting machines with weighted gear (to rapidly sink delectable baits).

"By the end of the workshops, the fishermen understood the protected-species issues much better and knew there were specific things they could do to improve their situation. Also, I think they felt good that they were able to ask specific questions and get answers," says Cousins, a Seabird Coordinator for the NMFS Western Pacific region.

In fact, one NMFS observer told Cousins that he had been approached after the first workshops by crew members who wanted to talk about seabird life spans and turtle biology, indicating a growing interest in the fate of the protected creatures. "Information is power," Cousins said, "and I think the fishermen feel less powerless about the situation now, because they know more—about their own industry, about species biology and avoidance techniques, and about the reason for regulations and restrictions."

The proud captains/owners of 10 Hawai'i longliners display their laminated photo-IDs and Protected Species Certificates earned at the fourth of five workshops held to educate longline fishermen about interaction with protected species; with them are Workshop Organizer Kathy Cousins and former NMFS Observer Eric Sandberg.

Who Came and What's Next

Nearly 100 owner/operators from 78 boats had attended the first four of five scheduled workshops by September 13th, and Cousins was optimistic about attendance by the remaining crews (of 164 longline permits in Hawai'i, there are only about 120 active vessels, leaving only one third of the fleet still to attend).

Though attendance at the workshops was voluntary this year, those who didn't attend could be excluded from fishing. Cousins says the U.S. Coast Guard and NMFS will conduct dockside checks of all registered vessels, and those whose crews don't have protected species certificates will be confined to port, or, if boarded at sea, required to return to port. To lessen the likelihood of such restrictions, Cousins says a final impromptu workshop may be held for those who didn't attend a scheduled presentation.

Finally, because of the positive response by longliners, and a proposed rule that will require annual recertification, Cousins says the protected species workshops may be repeated every year. Beyond that, the NMFS is thinking about expanding to have the same kind of workshops for bottom fishermen, and perhaps even general educational workshops for all fishermen, to provide them with the latest information and address their concerns.

PFRP

New PFRP Projects Funded in FY 2000

(1st year funding made available approx. September 2000)

Biology Projects

Developing Biochemical and Physiological Predictors of Long Term Survival in Released Blue Shark
PI: Chris Moyes, Richard Brill and Michael Musyl

Distributions, Histories, and Recent Catch Trends with Six Fish Taxa Taken as Incidental Catch by the Hawai'i-based Commercial Longline Fishery
PI: William Walsh and Sam Pooley

Pop-Off Satellite Archival Tags to Chronicle the Survival and Movements of Blue Shark Following Release from Longline Gear
PI: Michael Musyl and Richard Brill

Survivorship, Migrations, and Diving Patterns of Sea Turtles Released from Commercial Longline Fishing Gear, Determined with Pop-Up Satellite Archival Transmitters
PI: Richard Brill, George Antonelis, George Balazs and Jeffrey Polovina

Trophic Ecology and Structure-Associated Aggregation Behavior in Bigeye and Yellowfin Tuna in Hawaiian Waters
PI: Kim Holland, Richard Young, Richard Brill and Laurent Dagorn

Economics Projects

Regulatory Impact Analysis Framework for Hawai'i Pelagic Fishery Management
PI: Sam Pooley

Recreational Fisheries Meta Data—Preliminary Steps
PI: Paul Dalzell and Sam Pooley

Oceanography Project

Development of Oceanographic Atlases for Pelagic and Insular Fisheries and Resource Management of the Pacific Basin
PI: Russell Brainard, John Sibert and David Foley

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